not be so quick an incentive as glory, but it is a nobler one, and gives a tone to character which glory cannot impart. That unflinching devotion to work, without which no real eminence in science is now attainable, implies the writing at certain times of the stern resolve upon the student's character: 'I work not because I like to work, but because I ought to work.' In science, however, love and duty are sure to be rendered identical in the end."

THE TROGLODYTES OF THE VEZERE*

I HAVE come to speak to you about the Troglodytes of the Vezère, of that fossil population whose subterranean dwellings we are about to visit.

Their existence dates back to a startling antiquity. We do not know their name; no historian has mentioned them, not a vestige of them had been discovered until the last eight years; and yet they are better known to us, in many respects, than certain nations celebrated in classical history. We know their mode of life, their industry, their arts, and all the details of their existence. Is not this the true history of races, a history far more interesting than that of their battles, their conquests, and even their dynasties? How can we know so much of a people who have left no trace in the memory of man, and whose very existence would have been declared impossible twenty years ago? Are they the creatures of a dream, like the celebrated Troglodytes of Montesquieu? No. Nothing is more real than our Troglodytes; nothing more authentic than their annals. In the caverns which they inhabited, in those in which they laid their dead, have been found fragments of their meals, productions of their industry and arts, and remains of their bones. It is in this book that their history has been read; it is with these documents that their past existence has been resuscitated.

Many *savants* have taken part in these researches. Among others, Christy, the Marquis de Vibraye, M. Falconer, and our two colleagues, MM. Louis Lartet and Elie Massénat, deserve honourable mention; but there is one name that eclipses all the others, it is that of the founder of human palæontology—Edward Lartet.

I.—*Determining the Epoch*

Before speaking about a people it is well to assign it a place in time. But in this instance ordinary chronology is inapplicable. We are touching on periods of an incalculable length. Since the epoch when our Troglodytes lived, the climate and fauna have undergone considerable modifications, which have been produced slowly, without any revolution, without violent action, under the influence of those imperceptible causes which are still at work in our own day; and when we consider that, during the course of centuries of known time, these causes have only produced scarcely appreciable changes in our surroundings, we can have some idea of the prodigious duration of what is styled a geological epoch. These immense periods can neither be measured by years, by centuries, nor by thousands of years; these dates cannot be expressed in numbers, but we can determine the order in which the geological epochs followed each other, and the periods of which each is composed. These are the dates of the history of our planet; and the elements of what Edward Lartet has designated *palæontological chronology*. It will suffice for us to determine our dates from the commencement of the *quaternary epoch*.

The end of the tertiary epoch had been signalised by a remarkable phenomenon, of which the cause is not yet perfectly known. The northern hemisphere had gradually become colder. Immense blocks of ice, descending from the sides of the mountains into the valleys and plains, had covered a considerable portion of Europe, Asia, and North America; and the temperature of our zone, till then torrid, had by degrees become frigid. The duration of this cold period, called the *glacial period*, was excessively long. After having attained their farthest limits, the glaciers retired considerably, then they advanced again, but without regaining their former position. This was the last phase of the tertiary epoch. The glacial period was nearly at an end. A gradual modification of temperature caused the melting of the ice, and the quaternary epoch commenced. The glaciers, those immense masses of snow, hardened by time and accumulated during thousands of ages, produced, when they melted, gigantic torrents, sweeping along in their powerful waves the ruins of mountains, flooding the plains, ploughing up the soil, hollowing the valleys and leaving in their track large deposits of sand, pebbles, and argile. From that epoch, called the *diluvian*, are dated our present rivers, but they give us in these days but a faint idea of what they were then.

The extraordinary power of the water floods was above all remarkable during the early part of the quaternary epoch; it gradually decreased from that time, but it was not until the glaciers had retired within their original bounds, until the temperature had become nearly equal to that of our own day, that the phenomenon of the great inundations ceased, and that the quaternary epoch drew to a close. Since that time, we still find sand and pebbles displaced, and sometimes even masses of more or less volume torn from the sides of the valleys by the torrents, but the rivers and streams no longer bear along with them more than particles of clay and slime, and these deposits have formed alluvial soil. The whole period which has elapsed since the close of the quaternary epoch bears the name of *present epoch*, and the soil which has been formed in this period is called *recent soil*. It is, certainly, recent, if we compare it with the quaternary soil, but not with reference to our ordinary chronology, for several hundreds of ages must necessarily have elapsed during its formation.

These considerations will aid us in comprehending the most essential facts which have served to establish the dates of human palæontology. These dates are determined in the first place by pure geology, in the second by palæontology, and in the third by prehistoric archæology.

The geological dates are chiefly inscribed in the valleys and in the plains, where the great floods of the quaternary epoch have left deposits in the shape of layers more or less regularly stratified. Except where some event has disturbed or excavated the soil, the layers are superposed in order of antiquity. The oldest are found beneath and are called low level; above them are ranged the middle level, which succeed them, and which are, in their turn, covered by the layers of the upper level, dating from the latter part of the quaternary epoch. We find a layer more or less thick of recent soil, formed of accretions, turf, vegetable matter, &c., covering almost all the quaternary soil.

It must suffice to explain in a general way how the study of the stratification of the layers, termed stratigraphy, enables us to determine the relative age of the recent or quaternary deposits. This primary classification is purely geological. Thanks to the data which it furnishes, we can calculate the period of existence of those animals whose bones are found in the different layers; these animals in their turn serve to characterise periods, and can thus establish the dates of certain soils, or of those partial deposits which do not form a part of a complete and regular stratification.

1. Among the animals living in our land at the beginning of the quaternary epoch, some, like the mammoth, no longer exist save in a fossil state; these are the extinct animals; others, like the reindeer, have disappeared from our climate, but still live in other regions; these are the

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* Being the substance of the Address of M. Paul Broca to the French Association for the Advancement of Science, at the Session held at Bordeaux.

emigrant animals; others, like the horse, have survived to this day in our land, these are the existing animals.

The extinct animals abounded in the earlier quaternary age. Several were large and powerful mammalia, carrying terrible weapons of their own, and the human form looked weak and puny by their side. There were, among others, the great cave bear (*Ursus spelæus*), the great cave lion (*Felis spelæa*), the amphibious hippopotamus (*Hip. amphibius*), the rhinoceros with the expanded nostrils (*Rh. tichorhinus*), the ancient elephant (*Elephas antiquus*), finally and above all the giant, and we may say the king of this fauna, the mammoth (*Elephas primigenius*).

It would be superfluous to enumerate the other *extinct* species which lived at the same epoch. The reindeer and several animals, now *emigrants* like itself, were also to be found in this fauna, but they were still rare; and a good number of existing species had already made their appearance.

It is with good cause that the first period of the quaternary epoch, that which corresponds with the low level of the valleys has been called *the mammoth age*.

Every condition favourable to the prosperity of this species was then combined. But changes supervened which, in the long run, were to lead to its decay. The temperature had become less rigorous, and a great number of herbivora, till then stunted in their development by the inclemency of the atmosphere, had been able to improve and increase.

Already the mammoth saw arrayed against him the power of man, who, under this somewhat modified climate, could join in bands sufficiently formidable to declare war against him. Finally, and above all, this same climate, which suited his enemies and his rivals, had become hurtful to his own organisation, which required a colder temperature. The mammoth, therefore, so common in the earlier quaternary period, began to decline. We are inclined to think his existence was prolonged to the end of the palæontological age; but long ere that he had ceased to reign.

II. There was thus, in the middle of the quaternary epoch, an *intermediate age*, corresponding to the middle level of the valleys: an age in which several species contemporary with the mammoth were already extinct, in which others, represented only by solitary specimens, were on the point of disappearing, while those species were on the other hand flourishing, which were better adapted to the changing atmospheric conditions. Among these latter, the reindeer (*Cervus tarandus*) already occupied an important place, but it was in the succeeding period that it flourished.

III. This intermediate age gave way by degrees to the third and last stage of the quaternary epoch. When the layers of the upper level began to be formed, the species which we call extinct had almost entirely disappeared. A few rare mammoths still survived. Still more rare were the gigantic Irish deer (*Megaceros hibernicus*) and the great lion of the caverns. The rest of the fauna had but slightly changed, but the reindeer had multiplied to a wonderful extent. It formed at that time the chief nourishment of man. The third period of the quaternary epoch is therefore deservedly styled the Reindeer age.

The difference in the fauna of those days from that of our own time did not alone consist in the presence of the reindeer; many other hardy species, to whom a cold climate was necessary and a temperate one injurious, were still existing in our as yet frigid zone. When the state of the atmosphere more nearly approached that of the present day, there was a disappearance of the individuals which represented these species in our hills and plains; but the species themselves did not on that account perish. In the colder regions whither they had wandered they found a more congenial air, and they have thus been enabled to perpetuate themselves to the present time.

IV. The disappearance of the reindeer and of the other emigrant species marked the end of the quaternary epoch and of the palæontological age. Then began the modern epoch. Our climate was probably still a little colder than it is in our own days, but it was already temperate, and the slight changes which it has since undergone have not affected the conditions of life to such a degree as to endanger the existence of species. If the urus (*Bos primigenius*) and the aurochs (*Bison Europæus*) have disappeared from our land, we must attribute these results more to the destructive action of man than to that of climate,* and to man is also attributed the introduction of several new species, for the most part domestic animals. With these few exceptions, we may say that from the end of the quaternary epoch our fauna has not changed, and that the recent soil only contains existing species.

The dates which we seek to establish are therefore determined at the same time by stratification and palæontology. They also rest on data of another order, and these constitute a real science, namely prehistoric archæology.

The point which is certain and which has been irrevocably proved by Boucher de Perthes, is that the most ancient beds of the quaternary epoch contain vestiges of human industry. The knowledge of metals only dates, one may say, from yesterday; before possessing these powerful auxiliaries, man was not unarmed. In the manufacture of his weapons and tools he had employed several hard substances, the bones, the teeth of large animals, the horns of the Ruminantia, but above all, stone, and more particularly flint; hence the name *Stone age*, given in the history of man to all the period which preceded the use of metals.

This stone age still continues among some savage nations, and it only came to an end among the civilised people of antiquity at an epoch very little anterior to the historic age. Hence it embraces nearly the whole duration of human existence. Now the mode of fabricating weapons, their shape, their nature, must necessarily have varied during this immense period, according to the changes in the wants, the mode of life, and the social state of man who employed them; and if we now consider that hard stones will last an indefinite time in the ground, we shall understand that the tokens of this primitive industry constitute indelible medals and chronological documents of the highest importance.

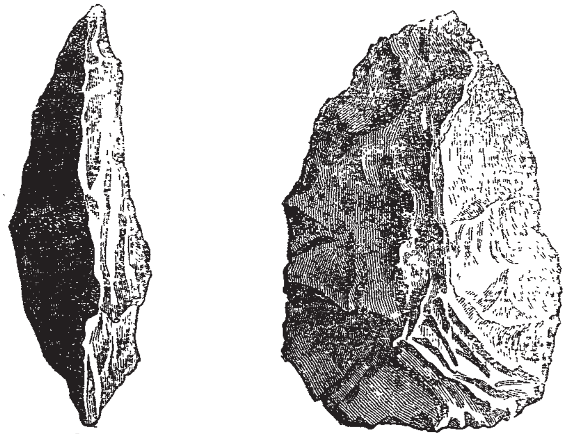

FIG. 2. FIG. 1.
The type of Saint Acheul; Hatchet carved on both sides. Fig. 1.—Front view. Fig. 2.—Edge view.

The dates established by prehistoric archæology agree pretty well, and sometimes coincide in a remarkable manner with those of palæontology and stratification.

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* The urus is now extinct, but it is not more than three or four centuries since it existed in Germany and Great Britain. The aurochs is only to be found now in a forest of Lithuania, under the protection of a special law of the Russian Empire. A troop of them has been also seen in the Caucasus

Just as certain species of animals have perpetuated themselves since the earliest quaternary epoch, in like manner certain forms of hewn flint have been found almost without change through several archæological ages.

You have just seen that geologists have been able, more than once, to determine and designate an entire fauna from a single characteristic specimen; archæologists, in like manner, have chosen in each case the most characteristic tool to distinguish the different periods of the Stone age. We cannot strictly determine these periods and their precise number, for working in flint may have had many modifications at the same epoch, but in different localities. However, in studying the question in its entirety, we may, following M. de Mortillet's example, reduce to three the number of archæological periods of the quaternary epoch.

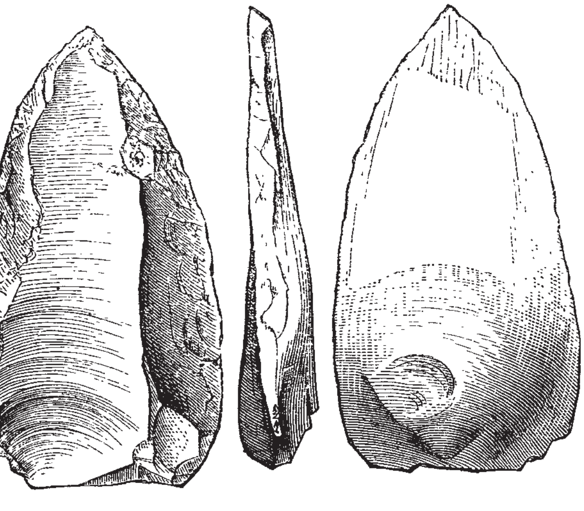

Fig. 4. Fig. 5 Fig. 3.
The Moustier type: Lance Point carved on one side. Fig. 3.—The plain side, cut out with one stroke; the projection of the bulb of percussion is visible at the base. Fig. 4.—The carved side. Fig. 5.—Edge view.

I. The most remarkable type of the early quaternary age is the hatchet of St. Acheul (see Figs. 1 and 2). It is a flint of varying bulk, always rather large, longer than it is wide, thick in the centre, graduated towards the edges, presenting one extremity pointed, or rather arched, while the other is rather rounded; and the predominant characteristic is its being carved on both sides, and the sides are more or less convex and more or less symmetrical. This type abounds at St. Acheul, near Amiens, in the valley of the Somme, hence its name; but it has been found in most of the beds of the Mammoth Age. It is sometimes, but rarely, to be met with in less ancient beds.

II. A second epoch of the Stone Age is characterised by the point of Moustier (see Figs. 3, 4, and 5). This weapon, which was fixed to the end of a huge lance, presents an exterior contour not dissimilar to that of the hatchet of St. Acheul, unless, perhaps, in being slightly more pointed; but its distinguishing mark lies in its being carved on one side only; the other side is cut out with one stroke, and has not been retouched. It is not therefore biconvex, like the other, but planoconvex, and consequently half the thickness.

The Moustier type takes its name from the Moustier Cave, where it is very common. It was not common until the intermediate period.

III. The art of cutting flint was perfected in a third epoch, which corresponds with the Reindeer Age. The pointed or sharp-edged weapons became less massive; the contours and sides were more regular, more symmetrical, and a delicate touching up, in fine little strokes, graduated them towards the edges. This period of the Stone Age is less marked by the nature of the weapons than by the style of workmanship. It is, however, agreed to take as a type the lance point of Solutré, because a short time since the lances found at the station of Solutré, in Maçonnais, were the best-cut weapons that had been extracted from the quaternary beds (see Fig. 6); but, since then, Dr. Jules Parrot, and his brother M. Philippe Parrot, have found at Saint Martin d'Excideuil (Dordogne), in a cave of the Reindeer Age, several flints carved in a yet superior style.

IV. We have now arrived at the end of the Reindeer Age. Directly the present epoch opens upon us, we see apparent in the flint cutting a further improvement, which marks the commencement of a new archæological era. Up to this time the flint had only been fashioned by pressure or percussion. They had learnt, it is true, to round by friction some objects in stone in a very rough style, but the weapons and tools in flint were always hewn. In the new era now commencing, many weapons were still made of cut flints; but from that time forth they knew how to polish them, and the polished hatchet, too well known to need description, became man's principal auxiliary (see Fig. 7).

This hatchet characterises the epoch of polished stone, or the neolithic epoch, which terminates the age of stone, and which, consequently, lasts until the introduction of metals. The entire period preceding the appearance of the polished hatchet constitutes the epoch of hewn stone, which is also called the archæolithic epoch, or better still palæolithic.

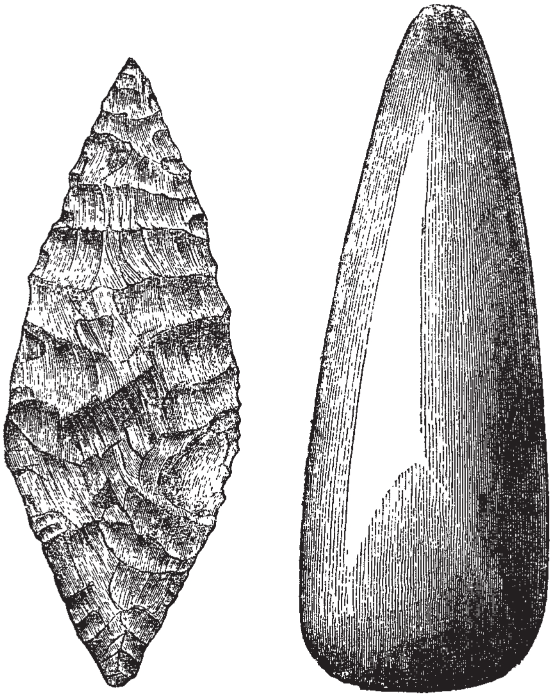

Fig. 6. **Fig. 7.**
Fig 6.—The type of Solutré: Lance Point of Solutré (Hamy. Human Palæontology). Fig. 7.—The Polished Hatchet.

The different phases of the epoch of hewn stone succeeded each other progressively, and by almost imperceptible transitions, like the corresponding geological periods; the epoch of polished stone, on the contrary, stands out clearly and almost abruptly from that which preceded it. Its commencement coincides exactly with the disappearance of the reindeer, that is, with the end of the palæontological age, and with the commencement of the present epoch of geologists. It likewise coincides with a complete change in the social condition of man, with the domestication of the dog, with pastoral life, marked by the domestication of several herbivora, and soon after with agriculture. A long succession of ages then elapsed, until the appearance of bronze, which put an end to the Stone Age. The epoch of polished stone was therefore a very long one; compared to this the whole period of historic time sinks into insignificance: nevertheless, this period of polished stone, however long it may appear to us, was infinitely shorter than any of those of which the epoch of hewn stone is composed.

(*To be continued.*)

THE ITALIAN REPORT UPON THE ECLIPSE OF 1870*

THIS is a folio volume about an inch thick, in a yellow paper cover. It is a well-printed book, made of tolerably good foolscap, and as the title-page informs us, produced at the expense of the Italian Government, under the care of Prof. Sir G. Hunter, as we should call him, but in his native tongue, Il Cavaliere Professore G. Cacciatore †; and the first remark that occurs to one on looking through it is that whether the Government paid handsomely, or whether it gave with a grudging stinginess, its cash was at all events well laid out, alike without extravagance and without meanness, and that the result reflects honour upon Italy.

On dipping into its contents here and there in a cursory way, the next thing you notice is the eager interest which the several contributors seem to take in their work, and the earnest simplicity with which they recount their experiences and achievements.

Speaking generally, the volume is a picture-book; the plates, some of them distributed through the letterpress, but accumulated in a considerable mass at the end, form an important feature of it, and will be found very interesting and suggestive even to those who are not so fortunate as to read the text.

For the convenience of the latter class of persons, I propose now to give a slight sketch of the report, beginning at the preface, and describing the several papers in the order in which they occur; and if, whilst doing so, I should venture to make any comments, the reader must remember not to attach too much weight to them, because it is hardly possible for a foreigner to do justice to men whose words and ways must always bear from his point of view something of the interest proper to pictures by the old masters. I ought not to presume to review this book critically, because, in the first place, the chief performers concerned in it are in every way my superiors; and in the second place, I am obliged to confess at once that they are personally so vividly present in my memory, that it seems almost a rudeness to analyse their writing for public uses.

I find it impossible to eliminate the romantic charm of their manners, and my own recollections of the high courtesy they showed towards us when we were associated with them in Sicily.

A slight reflection of this latter will be perceived by the reader the first time he opens the book. Fronting the title-page he will find a lithographed drawing of the station at Augusta, purporting to show the several observatories, in which those of the Italian astronomers are shown in the background; whilst the rough shed of the English observers, and the tents in which they were encamped, form the most prominent features of the picture. In passing from this first page of the volume, I must testify to the singular faithfulness of the drawing.

After the title-page there occurs a short paragraph, consisting of Prof. Cacciatore's apology for the delay in the production of the Report. (By the way, I wonder what our unfortunate editor will say in this respect when, after we are all dead and turned to dust, he produces at his own untold expense the English report of the same eclipse as an astronomical curiosity! Is not that a rather pathetic and suggestive reflection?)

Next follows the index, and then an address to the Minister of Public Instruction, from which it appears that a royal decree of July 5 of the year previous to the eclipse appointed a Commission consisting of Professors Cacciatore, De Gasparis, Donati, Santini, and Schiaparelli "to draw up a programme of the observatories, and to appoint the persons, the instruments, and whatever might be considered necessary to the success of the enterprise"; and of this Commission, Prof. Santini of Padua, was appointed president, and Prof. Cacciatore, of Palermo, vice-president. This address is signed by Santini, and recounts further how the Commission assembled in Florence in September 1869, and added to its numbers Professors Padre Secchi and Pietro Blaserna, of which, and of all its other proceedings, the Minister had been kept informed. Santini goes on to say that his present duty is to express the thanks that Science owes to that official for the eagerness he showed in backing them up with a considerable augmentation of the fund originally appropriated, and getting placed at their disposal a Royal steamship, and so on.

He then says that, owing to his advanced age, the chief burden of the work fell to the lot of Cacciatore, and that, thanks to his careful diligence, and so on, things were got ready nearly as intended; the "nearly" being a consequence of the extraordinary political changes of the preceding year. Cacciatore however seems to have found it no joke, and the part confided to him, he says, was very arduous and rugged ("ben ardua e scabrosa").

Here follows Cacciatore's account (*relazione*) of all that he did, and it forms, perhaps, the most interesting chapter of the whole book. The rest of the observers pass before the reader in single file, each relating what he saw and did, in his own words; but Cacciatore gives us a peep behind the scenes, and tells us what was done in the way of preliminary arrangement, and how he tried to aid every man in the manner best calculated to develope his own particular abilities; and in these operations (if I may be allowed to pass a remark) he appears to have done his work in a masterly way; and he relates the story with a graceful facility that makes it most attractive reading. He describes his preliminary canter over the course of the totality in search of a suitable site for the observatories; tells how he first examined the neighbourhoods of Villa 'Smunda and Terranova, as affording beyond all doubt the most favourable conditions, and how he afterwards reluctantly abandoned the former on account of its unhealthiness, and fell back on Augusta for his chief station, the fortress of which he describes, and says he found it admirably adapted for the purpose. Most truly it was so; and if I were to give an account of it, I should find Cacciatore's allowance of adjectives very inadequate to convey my impression of its attractions, although December was by no means the month in which they could be fairly appreciated.

Leaving his colleague, Tacchini, there to make preparations, he returned to his observatory at Palermo, which formed the base of operations. After this he gives a summary of the instruments, the observers, and the *role* assigned to each, and tells how he marshalled them in two complete and independent divisions, one of them destined for Augusta and the other for Terranova. On November 25 the steamer *Plebiscito* cast anchor at Palermo, having

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* Raporti sulle osservazioni dell'Eclisse totale di Sole del 22 Dicembre, 1870, eseguite in Sicilia dalla commissione Italiana.

† He always signs himself G. Cacciatore, but his first name is Gaetano.